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into the author's camp.

INTERGLACIAL FOSSILS FROM THE DON VALLEY,
TORONTO.

BY

A. P. COLEMAN, Ph. D., Prof. Met. and Assaying, School Pract. Sc.,
Toronto.

*The EDITH and LORNE PIERCE
COLLECTION of CANADIANA*



Queen's University at Kingston

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[From *The American Geologist*, Vol. XIII, February, 1894.]

INTERGLACIAL FOSSILS FROM THE DON VALLEY, TORONTO.

By A. P. COLEMAN, Ph. D., Prof. Met. and Assaying, School Pract. Sc., Toronto.

Fossils have been reported from a number of localities in the drift deposits of Ontario, those from the extreme east of the province being chiefly subarctic marine forms, while the species occurring in the center and west are mainly fossil land plants and freshwater shells with a few remains of deer, beaver and mastodon. Among the more important publications in which the Ontario drift fossils are referred to may be mentioned two papers by Prof. Chapman in the Journals of the Canadian Institute,* a paper by G. J. Hinde in the same journal,† a paper by Dr. R. Bell in the Canadian Naturalist and Geologist,‡ and the account of the superficial geology of Canada in the Geological Survey Report for 1863.§ In this report our superficial deposits are classified as follows:

2. {
 - Algoma sand.
 - Artemesia gravel.
 - Saugeen freshwater clay and sand.
1. Erie clay.

It is difficult to distinguish these deposits from one another in many cases, and there are such wide local variations that the classification is not always of value. Where the horizon of drift fossils is mentioned, they are generally referred to the Saugeen clay and its associated sandy beds or to the sands of raised beaches of postglacial formation. In most recorded instances the exact geological horizon of the find has not been determined, and the fossils may have come from postglacial rather than interglacial deposits. The only cases of undoubtedly interglacial fossils which I have seen reported are from Niagara Falls, where *Cyclas* was found in a sandy loam containing striated pebbles,|| and from Scarboro' Hights,** a few miles east of Toronto, where Mr. Hinde found three distinct layers of till with fossiliferous beds of sand and clay between the two lower ones. From these beds Mr. Hinde

*Vol. vi, pp. 221 and 497, etc.

†Vol. xv, p. 388, etc.

‡Feb., 1861, p. 42, etc.

§Vol. for 1863, p. 886, etc.

||Geol. Sur. Can., 1863, p. 902.

**Glacial and Interglacial Strata of Scarboro' Hights, Jour. Can. Inst Vol. xv, p. 388, etc.

obtained three species of diatoms, a Chara, five mosses, spores of Lycopodium, pieces of pine and cedar wood, portions of leaves of rush, etc., and seeds of various plants; as well as two or three species of Cypris, the elytra of a carabid, a Planorbis, a Zonites (doubtful),—in all a respectable little flora and fauna.

Fossils have been found frequently in the drift near Toronto. Prof. Hinde mentions the finding of trunks and branches of trees imbedded in the overlying yellow clay at depths of from ten to twenty feet below the surface;* and from the Don valley in the eastern part of the city pieces of half carbonized wood, and fragments of shells have been collected from time to time. They are first mentioned by Prof. Chapman† and Dr. Bell,‡ in 1861, who note the fact that a Melania and Unio ellipsis had been found by Dr. B. Workman under a deposit of sand about 30 feet above the lake.

While excavations were in progress for the straightening and embanking of the Don numerous fossils were obtained on the left bank of the river near the Gerrard street bridge, by Dr. Brodie and Mr. J. Townsend. Sir Wm. Dawson in 1890 refers to the finding of leaves, fragments of wood, and shells of Melania and Cyclas by the latter collector.§ In an appendix to the same paper Prof. Penhallow has figured a leaf found by Mr. Townsend, describing it as a new species under the name of *Acer pleistocenicum*.|| He determined other specimens from the same locality as follows,—*Asimina triloba*, *Ulmus racemosa*, and *Taxus baccata*. Mr. Wm. Spry, who was engineer in charge of the work during part of the time, informs me that there were tree trunks one or two feet through in the boulder-clay just above the underlying shale at Jail hill somewhat north of the bridge.

Since then a cutting on the Belt Line railway near the Winchester street bridge, half a mile above the previous locality and the west side of the river, has afforded many very fragile specimens of *Pleurocera*, *Valvata sincera* and *Sphaerium*

*Geol. Sur. Can., 1863, p. 904.

†Can. Jour., Vol. vi, p. 226.

‡Can. Nat. and Geol., Feb., 1861, p. 42.

§Bull. Geol. Soc. Am., Vol. i, p. 315.

||Idem, p. 328.

striatinum, as well as pearly fragments of *Unio*. The fossiliferous bed is sandy and reaches about 25 to 35 feet above the Don.

The most interesting exposure of all has recently been opened at the Messrs. Taylors' brickyard, nearly a mile north of the Gerrard street bridge. Many specimens of *Unio* have been collected here by myself, Mr. Blue, Mr. Townsend and the workmen employed in the quarry. The majority of them are so fragile as to fall to pieces with even the most careful handling; and it was only after following the advice of Dr. Dall, of the Smithsonian Institution, to soak the fossils in shellac varnish diluted with alcohol, that they could be at all satisfactorily preserved.

My thanks are due to Dr. Dall and his aid, Mr. C. T. Simpson, for the determination of the specimens, which include the following species,—*Pleurocera subulare*, *P. elevatum*, an undetermined species of the same genus and a single specimen which may be *P. pallidum*; *Valvata sincera*, *Sphaerium striatinum*, *Unio phaseolus*, *U. clavus*, *U. pustulosus*, *U. pustulosus* var. *schoolcrafti*, *U. occidens* (?), *U. luteolus*, *U. undulatus*, *U. rectus*, *U. trigonus*, *U. solidus*.

Mr. Simpson has described these fossils in the Proceedings of the U. S. National Museum* and states that at least three of the species of *Unio* and one *Pleurocera* are no longer inhabitants of the St. Lawrence drainage area, but belong to the waters draining into the Mississippi.

A list of the species now living in the vicinity of Toronto, made out for me by Dr. Brodie, includes only four of the species obtained at the quarry, viz. *Valvata sincera*, *Sphaerium striatinum*, *Unio luteolus* and *U. rectus*. Specimens of the two *Unios* which he has sent me are thinner-shelled than the fossils of the same species.

Three specimens of wood obtained at the quarry just above the lower boulder-clay were forwarded to Prof. Penhallow, of McGill University, for examination. As his report is appended to this paper, it is sufficient to state at this point that he refers the specimens, which he finds badly decayed and crushed, provisionally to the nearest living species, *Fraxinus quadrangulata*, *Quercus obtusiloba*, and *Taxus baccata*, var.

*Vol. xvi, pp. 591-595.

canadensis. The first two have not hitherto been reported from the Canadian drift.

In order to show definitely the geological horizon at which the fossils were found, the section exposed at Taylors' brick-yard has been measured, giving the following results:

	Feet.
1. Sandy soil followed by brownish grey clay with boulders	3
2. Stratified bluish grey clay (making buff brick)	69
3. Brownish or drab clay, much jointed (making red brick)	11
4. Brownish yellow stratified sand	4
5. Blue clay with peaty flakes	3
6. Brown sand and gravel (false bedding) with thin layers of blue or brown clay—fossiliferous	18
7. Blue clay (till) with striated boulders	3
8. Hudson River shales	30
	141

The Hudson River shales, which are quarried to make dark red pressed brick, rise about 30 feet above the Don, here practically at the level of lake Ontario; and are covered with a thin layer of typical boulder-clay containing finely polished and scratched fragments of the under-lying Cambro-Silurian rocks with a few stones of Laurentian origin. The residue of the clay after washing discloses particles of quartz, hornblende, feldspar, etc., evidently derived from Archæan rocks.

From the upper portion of the clay, which is indistinctly stratified, I have obtained Unios and the specimens of wood submitted to Prof. Penhallow. The Unios had evidently lived in the place where they were found, since they were not at all waterworn, still preserved their dark epidermis and frequently had the two valves attached. The till fills up all inequalities in the previously eroded surface and forms a floor with a gentle southward slope under the whole city. To the south it passes beneath the surface of the lake at some points.

I am informed by Mr. B. E. Walker that in excavating for the foundations of the Board of Trade building a few years ago two shark's teeth, apparently of Tertiary age, were found in the till. One of them is now in his possession. It is hard to account for this find, since no Tertiary rocks are known to exist this side of Hudson's bay. Some small outlier may lie hidden under the drift or may have been completely swept away by ice action.

Above the till we find 18 feet of sand with some fine gravel and a few thin layers of clay, a deposit formed in shallow water with shifting currents as shown by the false bedding. Well rounded pebbles of Laurentian and Silurian rocks occur, and the sands contain fragments of most of the minerals belonging to Archæan rocks. Some layers are brown from a deposit of hydrous sesquioxide of iron. Shells of *Pleurocera* and *Sphaerium* are common throughout the sand, and about eight feet above the till there is a layer containing many *Unios*, mostly separate valves more or less waterworn.

Above the sand is a bed of blue calcareous clay with flakes of peaty matter, then a bed of unfossiliferous sand, followed by a thick bed of distinctly jointed brownish clay, making red brick, probably corresponding to the Erie clay described in the Geological Survey Report for 1863.

This is succeeded by 69 feet of finely stratified bluish grey clay too calcareous for brick-making in the lower portions but yielding a buff brick from the upper layers. Very few pebbles or stones occur in it, the few that I have found being subangular with some faces polished and others rough. Under the microscope it appears to be a fine "rock flour" containing a few minute angular fragments of quartz, orthoclase, microcline, etc., as well as many indeterminable particles.

Towards the top this clay merges into an unstratified brownish clay with many boulders of Silurian and Laurentian origin, some fairly well rounded, others subangular and more or less striated. The line between the brown clay and the overlying sandy soil also is not well marked. In the soil and on the surface are many large Archæan boulders, one mass of gneiss measuring nearly six feet in longest diameter. The top of the section, 140 feet above the Don, is at the level of the plain on which the northern part of Toronto is built, a plain extending several miles to the westward, but cut off a quarter of a mile to the north by the Davenport ridge. Several other exposures along the Don and its tributaries or at railway cuttings in the neighborhood show similar sections of stratified sands and clays, but, as far as observed, without fossils. The upper boulder deposit is better displayed at the end of the C. P. R. trestle, a quarter of a mile to the south, than at the quarry itself. Here ten or fifteen feet of sandy

clay containing boulders, especially of limestone, beautifully polished and striated on some faces, form the uppermost layer, and rest upon the same thick bed of finely stratified bluish-gray clay observed at the quarry.

The Davenport ridge, really a plateau rising 30 or 40 feet above the plain to the south, is found, where laid open by cuttings for roads or railways, to consist in its upper part of unstratified sand with numerous pebbles and boulders distinctly polished and scored, the whole evidently a glacial deposit of somewhat different materials from those of the till at the bottom of the series. These glacial sands once extended much farther to the south than now, perhaps reaching the present lake shore, but wave action has washed them away, leaving behind the large boulders once so thickly scattered over the site of Toronto, though now mostly removed for road-making purposes.*

Comparing the section just given with one kindly furnished by Dr. Brodie from a locality now buried from view, at the Winchester street bridge, there are below the level of the lake, resting on Hudson River shale, six feet of uncertain materials, five feet of a deposit containing leaves, wood and *Cyclas goniobasis* (?), and five feet of till with boulders differing from those found higher up. The upper part of this bed rises a little above the level of the lake. Upon this follow first a lacustrine deposit, say fifteen feet, with wood, leaves, *Cyclas* and *Unios*; next, glacial clay with very large boulders of gneiss, etc.; and finally lake shore sand, not continuous.

A somewhat different account of the section is given by Mr. Townsend, as quoted by Sir Wm. Dawson.† Reversing the order in which Mr. Townsend arranges the series, we find blue till resting on the Hudson River beds; then sixteen feet of alternating sand and dark-colored clay with freshwater shells and wood; three feet of ferruginous sand with argillaceous nodules (one containing a maple leaf); twenty-four feet of tough, stratified blue "Erie clay;" and finally twenty-six feet of fine, light-colored sand, with layers of clay at bottom.

The lowest fossiliferous deposit, mentioned by Dr. Brodie

*Glacial Phenomena of Canada, etc., Prof. Ramsey, Can. Nat. and Geol., 1859, pp. 328. He gives a section of Toronto drift, showing boulders.

†Bull. Geol. Soc. Am., vol. 1, p. 315.

but not by Mr. Townsend, is perhaps preglacial. The fifteen or sixteen feet of lacustrine deposit just above the till, correspond to the *Unio*- and *Pleurocera*-bearing beds of the brick-yard.

The section measured by Mr. G. J. Hinde at Scarboro' Hights differs more widely from the one described in the present paper, since there the lowest boulder clay is separated from the second by 140 feet of fossiliferous clay and sand.* It is clear that our drift deposits vary greatly within comparatively short distances.

In interpreting the facts observed in the Don valley we have a first Ice age in which the glacier worked up the Hudson River shales into boulder clay, kneading in a few Archæan boulders, and spreading a tough carpet of till in a gentle slope toward the hollow of lake Ontario, and then withdrew; followed by the waters of the lake, which stood 40 or 50 feet above its present level, if we suppose no change in the hight of land above sea at this point. Mr. Simpson supposes that the lake was ice-dammed at this stage,† and drained into the Mississippi, making it possible for mollusks belonging to the Mississippi fauna to invade waters normally flowing into the St. Lawrence. The supposition is a natural one, but seems contradicted by the fact that at present the watershed between lake Ontario and the tributaries of the Mississippi is several hundred feet above the level of the lake. I have seen no reports of buried channels going low enough to drain lake Ontario into the Mississippi down to a level only 50 feet above the present, though of course, the possibility of finding one cannot be denied. There seems more evidence of an old channel leading past Syracuse through the Mohawk valley into the Hudson,‡ which would not account for the presence of Mississippi forms in Ontario, however. In whatever way they were introduced, there is no doubt that during interglacial time eight or ten species of *Unio*, several no longer found in our waters, lived at the mouth of the Don, first on the scarcely disturbed surface of the till, afterwards on beds of sand and well rolled gravel brought down by the river and

*Jour. Can. Inst., vol. xv, p. 392.

†Proc. Nat. Museum, No. 952, p. 593.

‡Wright, Man and the Glacial Period, p. 202.

spread in its shallow estuary. On the banks of the prehistoric Don grew trees such as now flourish in the same region, yews and cedars, maples, oaks and ashes; as well as the papaw, now, I believe, not occurring north of the lake. Judging by the flora and fauna the climate was by no means subarctic, but on the contrary fully as mild as at present, if not a little milder.

The length of the interglacial time was sufficient for the deposit of 24 feet or more of sand and clay on the Don and 140 feet of similar materials at Scarboro' Hights, and for the growth of large forest trees.

It is generally supposed, from the direction of glacial stria-
tions and of the transport of boulders, that the center from
which the ice radiated was at the watershed between the St.
Lawrence and Hudson bay or somewhat farther east in Lab-
rador, at the farthest not more than 700 miles from Toronto.
At the present time in southern British Columbia névé is
scarcely found on mountains rising less than 8,000 feet above
sea level, and glaciers hardly come down to 5,000 feet. It is
probable that a depression of the highest points to 7,000 or 8,000
feet would completely wipe out all the glaciers of southern
British Columbia. So far as I am aware, no point reaches
3,000 feet above sea level between Ontario and Hudson bay,
and no point in Labrador rises much above 6,000 feet. Unless
the northern watershed stood very much higher above lake
Ontario than at present, it is impossible to imagine a wide
spread sheet of ice existing there during interglacial time,
when oaks and maples and papaws flourished on the land and
Mississippi Unios in the waters only 400 or 500 miles to the
southeast. I know of no evidence proving that the glacial
center stood at that time 3,000 or 4,000 feet higher above lake
Ontario than at present, and hence conclude that the ice fields
were completely melted during the interglacial epoch, instead
of merely receding a comparatively short distance before ad-
vancing again.

After the deposit of the fossiliferous beds the lake rose to
at least 140 feet above its present level, perhaps dammed at
its eastern end by the return of the ice during the second gla-
cial period, and thick beds of clay were laid down in quiet
water. Probably the Don at this time was a glacial stream,

bringing down rock flour from the not far distant ice front, as the upper waters of the Athabasca now do, and depositing it on the floor of a lake too muddy and cold for life.

A further advance of the glacier buried the stratified clay beneath 30 or 40 feet of sandy clay and sand containing numberless subangular, striated stones and some boulders of Laurentian and Silurian rock several tons in weight. These materials show little or no stratification and are not waterworn so far as I have observed. The striae on limestone pebbles are sharp, and there are flat pebbles of soft Utica shale here 20 miles from home, which would have been destroyed if transported by wave action or by running water. The clays under this second glacial deposit appear to have been very little disturbed by the passage over them of the glacier.

When the ice of the second glacial epoch retreated, the lakes, whether dammed by an eastern tongue of ice or lowered to the level of the sea, formed a beach now 140 feet or more above the lake, Spencer's Iroquois beach.* Wave action removed the loose materials as far as the Davenport ridge, which forms so prominent a feature of the northern part of the city, the heavier stones being left where they rested as a boulder pavement. At the Iroquois stage the lake is considered to have drained into the Hudson. Several of the Unios exterminated by the second advance of the ice did not return when the ice retreated again. Was the continuously icy water unfavorable to the species which failed to return? Mr. Simpson supposes that some change in the drainage system prevented them from regaining the lost ground.† The change from the Iroquois level to the present one must have been rapid, leaving no time for the formation of intermediate beaches. Since the change of level the Don and its tributaries have had time to remove the drift deposits down to base line for more than a mile north of Toronto bay.

NOTE ON INTERGLACIAL PLANTS FROM THE DON VALLEY.

By Prof. D. P. PENHALLOW, McGill University, Montreal.

From time to time there have been brought to light a number of interesting plants from the interglacial formation of

*Deformation of Iroquois Beach and Birth of Lake Ontario, Am. Jour. Sci., Vol. XL, Dec., 1890, p. 446.

†Proc. Nat. Museum, Vol. xvi, p. 595.

the Don valley near Toronto. These, chiefly in the form of lignite, have thrown much light upon the vegetation of that time, and show that in the arborescent forms at least, the species were such as may now be found in the same region. On the 7th of November, 1843, Prof. A. P. Coleman, of Toronto, sent me three excellent specimens of interglacial lignite for determination. They represented fragments of branches which must have been several inches in diameter when growing. Outwardly the material appeared well preserved, and after boiling in carbonate of potash for about two hours was found to be sufficiently soft and free from siliceous matter to section freely. It was therefore imbedded in paraffine and sectioned on a microtome.

Upon examination of the sections it was found that the structure had been greatly altered by decay and compression, so that, with the exception of number two, reference to species could not be made with certainty.

As, however, previous experience has shown the close identity between the interglacial vegetation and that of our own time in the same locality, it is probably admissible to refer doubtful species to those modern species which they most nearly approach, and it may be that future material, more perfectly preserved, will enable us to decide more definitely as to the specific value of such provisional reference. There is, at any rate, the great advantage of avoiding the introduction of new names which may hereafter require to be abolished.

No. 1. *FRAXINUS QUADRANGULATA* Michx.

The specimen marked No. 1, was much altered by compression and decay, so that the transverse section was much disturbed, while the longitudinal sections exhibited but poorly a very few of the characters upon which specific distinction is to be based. From the former, however, it was at once clear that the plant was a *Fraxinus*, and as, of existing species, it seems to approach most nearly to *F. quadrangulata*, I consider it proper to refer it, provisionally, to that species. So far as I am aware this is the first record we have of this genus in the interglacial of Canada. *Fraxinus quadrangulata* is at present found in Canada along the shores of lake Erie, and particularly about point Peter. (Macoun.)

No. 2. *TAXUS BACCATA* L., var. *CANADENSIS* Gray.

Specimen No. 2 showed the characteristic structure in cross section very clearly. In longitudinal section the usual markings of the tracheid walls were found to be largely obliterated, even to the bordered pits,

but enough evidence remained to enable me to refer the specimen without doubt to *Taxus baccata* L., var. *canadensis* Gray.

This species has hitherto proved a somewhat common one in the interglacial of Canada, particularly in the Don valley.*

No. 3. *QUERCUS OBTUSILOBA* Michx.

Specimen No. 3 showed considerable alteration. While in transverse section the quercic characters are well defined, in longitudinal sections the structural markings were almost obliterated. The resemblance of this wood to modern oaks was found to be most marked in the case of *Quercus obtusiloba* Michx., to which I therefore refer it, provisionally. This is the first time an oak has been found in the interglacial of Canada.

Quercus obtusiloba is now found in southern Ontario, and particularly about the bay of Quinte (*Macoun*).

*The Pleistocene Flora of Canada, Bull. Geol. Soc. Am., 1, 321.

The American Geologist

Was begun January 1, 1888, and has been issued monthly since that date. It is not the organ of any institution, nor of any section of the country, nor of any party.

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